Pesticides, Noxious Weed Control, and Chemical Drift Protection in Kansas

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This paper is intended as a brief overview of current pesticide and noxious weed law in Kansas, to provide background on pesticide use, trends and emerging problems. It is by no means a comprehensive review but is intended as a starting point for a more complete review, discussion and debate on the critical issues and problems, and all possible solutions.

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Table of Contents

Executive Summary	4
Introduction and Basic Terms	7
Pesticides	8
Notable Pesticides Used in Kansas	10
National Trend for Notable Pesticides	11
Proliferating Problems with Pesticides	12
History and Legal Background	15
Kansas Pesticide Law	16
Kansas Noxious Weed Law	19
Another Option	20
Recommendations	22
Conclusion	23
References	24
Endnotes	26

Executive Summary

The purpose of this paper is to provide background information on pesticide law in Kansas, including the noxious weed law, current pesticide usage and trends, and to describe emerging problems and issues and recommendations for Kansas' pesticide use and noxious weed law as well as for farming practices and research needs. This paper is by no means a comprehensive review of all these issues but should be seen as a starting point for a more complete review, discussion and debate of the critical issues and all possible solutions.

Over the last three years, Kansas lawmakers and agricultural interests have suggested revising Kansas' Noxious Weed Law by transferring government authority to the executive branch from the legislative branch to access more expertise and develop more rapid, proactive approaches. Controlling noxious weeds and invasive pests is important, but revising only the noxious weed law begs a larger, more complicated question about the impact of increasing use of pesticides and the efficacy of these pesticides, and the issue of drift onto non-targeted sites.

Weeds and pests have long been a problem for farmers and ranchers. However, the ways we manage weeds and pests today are creating larger problems. Despite years of attempting to control weeds including those designated as noxious weeds, we have more problems today than in the past including: the scope and volume of chemicals used today, the amplification of chemical drift concerns, the development of genetically-resistant 'superweeds', the peril of plant pollinators, and the development of genetically-engineered seeds bred to be resistant to specific herbicides, resulting in an increase in their use.

The predominance of chemical pesticides in our agricultural system has also been found to cause cumulative harm to humans and natural ecosystems, and increasingly results in weed and pest resistance, resulting in an ongoing escalation in the quantity and strength of chemicals used. Presently, scientists can find traces of pesticides in nearly every American's body, as studies show the prevalence of these chemicals on most food and in a majority of streams in the United States.[i] Scientific studies increasingly link an array of human health problems to pesticide exposure, as well.[ii]

Given the above-mentioned problems or issues caused by pesticide use, the real question is: can we reduce our pesticide dependency and evolve our farming practices and land management strategies to control and manage weeds and other pests that threaten agriculture and the environment? What policies and practices will achieve that goal?

Recommendations.

Recent proposed legislation has focused on questions surrounding a change in authority of the state's noxious weed law or on adding additional weeds to the state list or county special list. However, as we stated earlier, focusing solely on noxious weeds begs the broader question of pesticide use in general, and ignores the problems or issues plaguing current use, and ignores potential issues with expanded use of chemical controls. Adopting an approach that encourages or incentivizes non-chemical or cultural, biological controls would lessen the danger or threats from those who do opt to use chemical controls, and could actually help maintain the efficacy of chemical controls. Such an approach that meshes the

needs to build soil health, protect water quality, and limit human exposure to pesticides provides the most workable, practical approach for a long term sustainable future.

Recognizing that the Kansas State Legislature is likely to address noxious weed law regardless of the other pressing issues surrounding pesticide use, we offer recommendations below to address improving the state's noxious weed management program separate from comments on developing an overall pest management approach that would lessen dependency on chemical pesticides for agriculture as a whole.

The opportunity to reverse or reduce our dependence on chemical pesticides and broaden our approach to managing weeds and pests in modern agriculture may be closer than ever with enhanced science and technology, public knowledge, and integrated pest management strategies.

Noxious Weed Law

1. Develop or improve the existing education and outreach on controlling noxious weeds to landowners, farmers, and ranchers to encourage greater management efforts.
2. Encourage non-chemical approaches the same way we encourage or incentivize chemical controls. It will take an integrated approach to address serious infestations.
3. Create a State Pesticide Management Advisory Council to address both noxious weeds and pesticide drift with well-balanced expertise including agro-ecology representatives, and certified organic or specialty crop representatives. Task the Council with developing a risk assessment process for identifying transformative invasive weeds and prioritizing needed research into topics and issues that will expand Integrated Pest Management solutions.
4. Protect private property rights of landowners and farmers and ranchers by leaving the ultimate authority of declaring noxious weeds in the hands of the State Legislature, with the input and advice of a State Pesticide Management Advisory Council.

Pesticide Law and Chemical Drift Protection

1. Develop or improve education, funding, research, and outreach on Integrated Pest Management practices for Kansas agriculture.
2. Define pesticide drift and develop protections for those impacted by it.
3. Create an additional authority in the administrative adjudication process (K.A.R. 4-13-40) for parties to voluntary opt for resolving pesticide drift damages and compensation via "consent to mediation" instead of having to go to court.
4. Explore opportunities to expand insurance options for the pesticide applicator and/or specialty crop grower to enhance protections in chemical drift circumstances.
5. Create a recordkeeping or permit obligation, such as a logbook or county call-in, that requires private applicators to record details of their pesticide application: such as the area, location, method, time, and date of their application, type and amount of pesticide(s) used, wind direction and velocity, and whether notification to adjacent property owners was given.
6. Implement a mandatory Driftwatch program with landowners, farmers, and ranchers to submit sensitive crop location information so that those applying pesticides can quickly and easily identify areas needing greater protection.
7. Review and monitor controversial pesticides (such as Dicamba and Chlorpyrifos) to consider designatation as restricted use status (under state law) in order to protect the Kansas agriculture economy, private property rights, public health and environmental damage, and right-to-farm fairness between farmers. Prepare a state plan to address potential conflicts.

As agriculture continues to evolve and consumer awareness of public health and environmental damage continues to grow, the discussion of pesticide use, weed control, and drift protection will expand. The conversation will enter even more into statehouses and courtrooms, as well as talks between neighbors. The best outcome can be gained through a proactive, cooperative approach in which all parties involved agree to listen, be forward-thinking, and to practice better responsibility and stewardship in all their capacity.

Advances in technology, farming and land management systems, and government policies can all aid the necessary agricultural transition from a pesticide-based agricultural model to that of agroecology and the common acceptance of sustainable farming and integrated pest management. With heightened accountability, creative-thinking, and open-mindedness at the individual, societal, and ecological levels, Kansans and the rest of the global community can work to solve the challenges of noxious weeds and pesticide dependence successfully together.

Introduction

Weeds and pests have long been a problem for farmers and ranchers. Chemical pesticides are commonly seen as the most effective response, and are typically used as the primary land management tool. However, the enormous dependency upon chemical pesticides is turning out to be a problem in and of itself. Science is demonstrating pesticides' decreasing chemical effectiveness as plants and insects are developing resistance. This reality means farmers are using more pesticides for the same prior effectiveness, and also that a greater number of hazardous chemicals or chemical *combinations* are being used. For farmers, increased chemical use means higher input costs, which impacts profits.

Scientists are discovering that modern pesticides are more carcinogenic, pathogenic, and systemically detrimental to public health and wildlife than previously expected. Additionally, there is intensifying concern, both in liability and reconciliation, over the issue of chemical drift.

Additionally, despite years of attempting to control noxious weeds, primarily with chemicals, Kansas continues to have problems with them. Noxious weeds are those invasive unwanted plants harmful to agricultural crops, ecosystems and livestock. Kansas currently identifies twelve statewide noxious weeds and two optional weeds for county control. All 105 Kansas counties currently have noxious weeds[iii] and each year these counties and the state spend over a million dollars fighting noxious weeds.[iv] In 2016, Kansas had 93,549 acres of Bur Ragweed, 362,946 acres of Johnsongrass, 498,883 acres of Sericea Lespedeza, 740,334 acres of Musk Thistle, and nearly 1.6 million acres of Field Bindweed.[v] These weeds can push out native plants, destroy wildlife habitat, transform natural ecosystems and farming operations, and decrease property values. Noxious weeds, along with threats of new weeds and pesticide-resistant weeds, present serious threats to agriculture, the environment and the agricultural economy.

Over the last three years, Kansas lawmakers and agricultural interests have suggested revising Kansas' Noxious Weed Law by transferring government authority to the executive branch from the legislative branch to access more expertise and develop more rapid, proactive approaches. Controlling noxious weeds and invasive pests is important, but revising only the noxious weed law begs a larger, more complicated question about the impact of increasing use of pesticides and the efficacy of these pesticides, and the issue of drift onto non-targeted sites.

Given the above-mentioned problems or issues caused by pesticide use, the real question is: can we reduce our pesticide dependency and evolve our farming practices and land management strategies to control and manage weeds and other pests that threaten agriculture and the environment? What policies and practices will achieve that goal?

The purpose of this paper is to provide background information on pesticide law in Kansas, including the noxious weed law, current pesticide usage and trends, and to describe emerging problems and issues and recommendations for Kansas' pesticide use and noxious weed law as well as for farming practices and research needs. This paper is by no means a comprehensive review of all these issues but should be seen as a starting point for a more complete review, discussion and debate of the critical issues and all possible solutions.

Basic Terms

Pesticide:
A chemical substance used to kill insects, small animals, wild plants, and other organisms. Pesticides include classes of herbicides, insecticides, fungicides, and more. As defined in Kansas Statute 2-2438a – "Pesticide" means, but is not limited to: 1) any substance or mixture of substances used to prevent, destroy, control, repel, attract or mitigate any pest; and 2) any substance intended to be used as a plant regulator, defoliant, or desiccant.

Drift:
Pesticide spray drift is the movement of pesticide dust, vapor, or droplets through the air at the time of application or soon after, to any site other than the area intended. For farmers, pesticide drift often concerns the effect of chemical damage to, or from, neighbors' land and crops. However, farmers near populated areas or water sources must consider runoff, exposure to humans, and infiltration of aquatic ecosystems and drinking water. Drift is not currently defined in Kansas Statute.

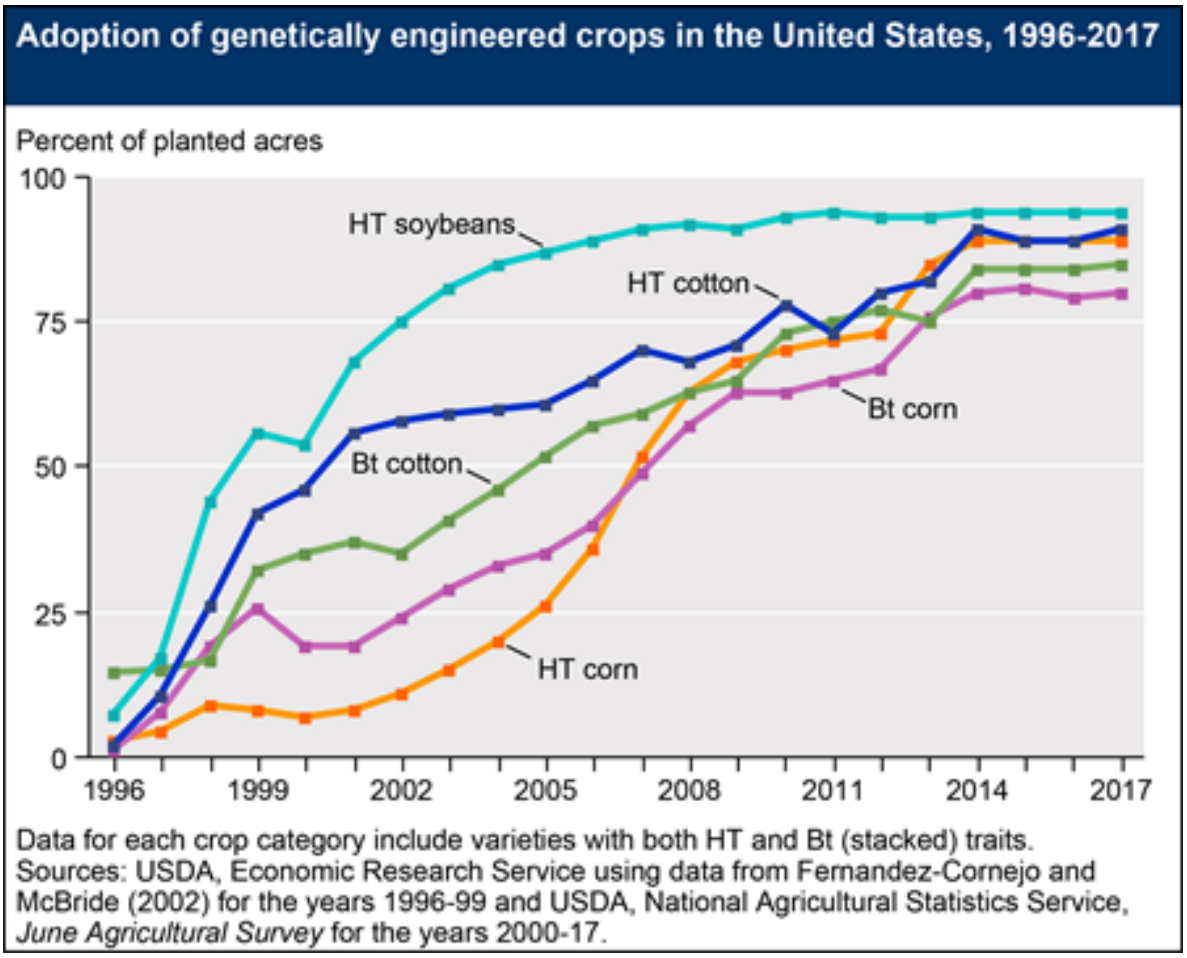
Noxious Weed:
A noxious weed is an invasive, unwanted plant which is designated as harmful to agricultural crops, ecosystems, humans, or livestock. Kansas has listed 12 statewide noxious weeds, and two optional extras, for counties to control and eradicate. The weeds are: Kudzu, Field Bindweed, Russian Knapweed, Hoary Cress, Canada Thistle, Musk Thistle, Johnsongrass, Leafy Spurge, Bur Ragweed (or Bursage), Pignut, Quackgrass, and Sericea Lespedeza. Bull Thistle and Multiflora Rose are the additional county options. K.S.A. 2-1314(a-b).

Pesticides

Over the years, pesticides have aided the agriculture industry with the ability to increase crop production, preserve produce, combat insect infestations, and control invasive and exotic species. But pesticides - essentially biological poisons by definition - do have their drawbacks, especially as they become more predominant. **Today, about 1.1 billion pounds of active ingredient pesticide are used in the United States,** accounting for roughly a fifth of the worldwide total.[vi] With over 20,000 pesticide products on the market today[vii], **American pesticide use has skyrocketed five-fold since 1960.**[viii]

In the United States, 80% of pesticide use is attributed to agriculture.[ix] Farmers deploy pesticides in a variety of ways, including aerial spraying, tractor sprayers, chemigation, spot-spraying, and seed treatment. As far as the type of pesticide used, herbicides are the front-runner, though insecticides are quite common, even with the adoption of genetically-engineered seed and insecticidal seed treatments. For example, according to the USDA, **over 95% of American corn and soybean acres are already sprayed with Glyphosate**, but new GE seeds enable even more. Herbicide-tolerant seeds, along with chemical-resistant superweeds, have led to an uptick in herbicide use in recent years. Resistant insects have similarly increased insecticide application.[x]

Kansans apply millions of pounds of pesticides across millions of acres of pastureland and cropland to control plants and insects every year. In Kansas, the most common herbicides are used on crops, particularly corn fields. The most common herbicides are Glyphosate, Atrazine, 2,4-D Metolachlor-S, Acetachlor, and Dicamba. The most common insecticides are Imidacloprid, Clothianidin, Thiamethoxam (all neonicotinoids), Chlorpyrifos (an organophosphate), Bifenthrin and Permethrin (pyrethroids).[xi]



Herbicide-tolerant (HT) crops, which tolerate potent herbicides (such as glyphosate), provide farmers with a broad variety of options for effective weed control. Based on USDA survey data, the percent of domestic soybean acres planted with HT seeds rose from 17 percent in 1997 to 68 percent in 2001 to 94 percent in 2014. HT cotton acreage expanded from approximately 10 percent in 1997 to 56 percent in 2001, before reaching a high of 91 percent in 2014. Currently, approximately 89 percent of domestic corn acres are produced with HT seeds. **Insect-resistant crops**, which contain genes from the soil bacterium Bt (Bacillus thuringiensis) and produce insecticidal proteins, have been available for corn since 1996. Domestic Bt corn acreage grew from approximately 8 percent in 1997 to 19 percent in 2000, before climbing to 81 percent in 2015.[xii]

Notable Pesticides Used in Kansas[xiii]

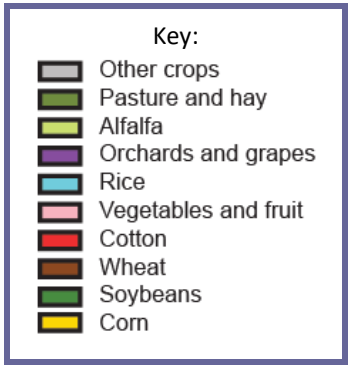
Common Name	Brand Names	Type	Common Uses	Low-estimate Use in KS by USGS (2014)	Prevalence in USA By USDA/NASS (2012)	Risk to Health & Environment
Glyphosate	Roundup, Rodeo, Glyfos, Quikpro, Touchdown, and more	Broad-spectrum systemic herbicide General Use;	Crops, pasture, lawn and turf, and noxious weeds	18,899,209 lbs.	#1 used pesticide in American agriculture; usage is 270-290 Million lbs. in 2012	World Health Org. declared it a probable human carcinogen in 2015 and California has labeled as a known carcinogen (2017). Creating plant-resistance from overuse
Atrazine	AAtrex, Atrazine, Guardsman Max, Acuron, Basis Gold, and more	Herbicide, Photosynthesis inhibitor Restricted Use	Preemergence and postemergence for Corn, sorghum	7,213,060 lbs.	#2 most-used pesticide; 64-74 million lbs. estimated in 2012. The most common herbicide used for corn production	Endocrine disruptor, reproductive effects, and likely carcinogenic. Top pesticide found in drinking water. Soil persistence is 1year+. Banned in the EU in 2003 for wide-prevalence in water systems
2,4-D	Opt-Amine, Barrage, Weed-B-Gone, Weedar 64, and more	Synthetic Auxin, General Use Herbicide	Corn, Soybeans, Wheat, Ranchland, lawn and turf, and noxious weeds	4,265,768 lbs.	#5 most used herbicide in U.S at 30-40 million lbs. in 2012	Possible carcinogen, endocrine disruptor; moderate toxicity for birds and mammals
S-Metolachlor & Metolachlor	Bicep, Dual, Cinch, Pennant, Pimagram	Biosynthesis inhibitor Herbicide; Some General, Some Restricted Use	Preemergence and postemergence for corn, soybeans, sorghum, fruit and nut trees, noxious weeds	3,565,620 lbs. & 766,730 lbs. respectively	Ranks #3 as herbicide most used; 34-44 million lbs. in 2012; Estimated #15 most used, with 4-8 million lbs. used in 2012	Possibly carcinogenic and cytotoxic; most studies show low toxicity for mammals, birds, and insects
Dicamba	Banvel, Clarity, Distinct, Status, Vanquish, Vision, Diablo, Oracle, Rifle	Broad-spectrum Benzoic Acid Herbicide Mostly General Use	Corn, Soybeans, Wheat, Pasture, and noxious weeds	1,512,534 lbs.	Estimated rank in top 20 with 3-7 million lbs. applied each year	Suspected to be a human teratogen (birth defects) and reproductive toxin. Extremely mobile in soils and persistent (2mos to 1yr). Recently barred in Arkansas and Missouri for drift problems.
Acetochlor	Guardian, Harness, Surpass, Warrant, Keystone, Degree, Cadence, Breakfree	Choloroacetanilide Herbicide, Mostly Restricted use	Mostly Corn, but some Soybeans, and Lawn & Turf	1,483,303 lbs.	#7 in 2012's most used pesticide with 28-38 million lbs. applied	Probable Carcinogen and may affect Thyroid. Often detected in drinking water samples. Class I Toxicity
Dimethenamid-P	Outlook, Tower, Frontier, Slider	Seedling growth inhibitor, Some General Use, Some Restricted	Preemergence for Corn, Mostly lawn and turf	292,588 lbs.	Not listed in top 25 for commonly used pesticides	Concern for liver damage, and neurological, reproductive, and nervous system harm. Moderately toxic for aquatic wildlife, but low mammalian toxicity
Sulfentrazone	Dismiss, Spartan, Antares, Authority, Blanket, Solitaire	Cell membrane disruptor Mostly General Use	Preemergence for Soybeans	230,822 lbs.	Not listed in top 25 for commonly used pesticides	Not likely a carcinogen, but concern on reproductive and developmental harm. Some risk to aquatic organisms
Mesotrione	Callisto, Tenacity, Incinerate, Explorer	Pigment inhibitor Mostly General Use	Preemergence and Postemergence for Corn and Lawn and Turf	214,955 lbs.	Not listed in top 25 for commonly used pesticides	Teratogen and neurological concern. Relatively low-risk to wildlife
Chlorpyrifos	Eraser, Govern, Lorsban, Nufos, Pilot, Whirlwind, Warhawk, Yuma	Organophosphate & broad-spectrum insecticide; Some general, restricted	Corn, soybeans, vegetables, lawn and turf	171,372 lbs.	#14 most used pesticide in US in 2012, and the most common insecticide in US agriculture (for a non-seed treatment)	Chlorpyrifos harms the nervous and endocrine system and is linked to neurological and developmental dysfunction in children. Banned for household use in 2001. Very persistent environmentally too

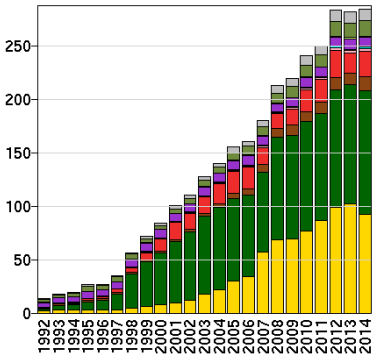
"Estimated Annual Agricultural Pesticide Use." U.S. Geological Survey. Page Last Modified February 01 2017. Accessed 20 June 2017

Estimated Annual Agricultural Use of Notable Pesticides in the United States

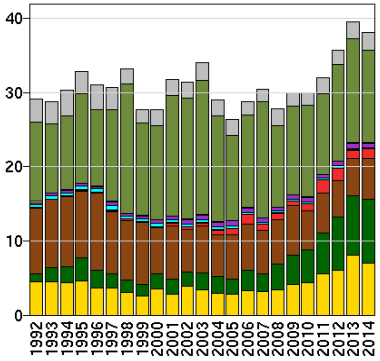
Displayed by Year (X-axis) and Crop (by color key)

Estimated Use in Millions of Pounds (Y-axis)

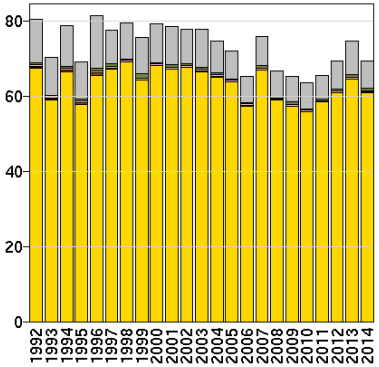




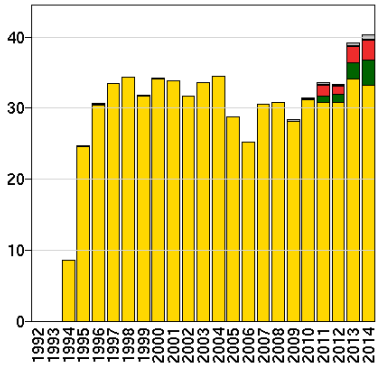
Glyphosate



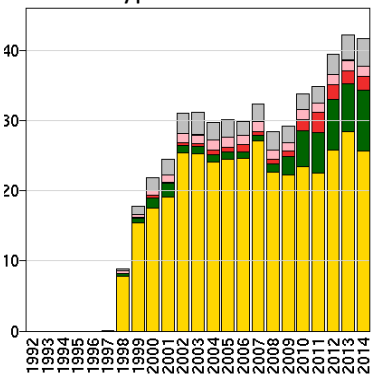
2-4D



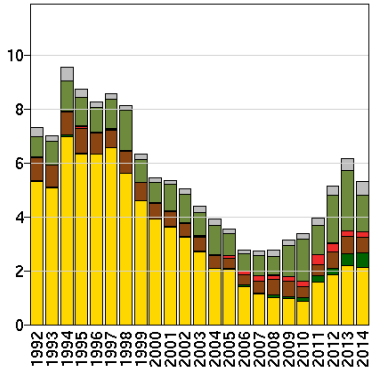
Atrazine



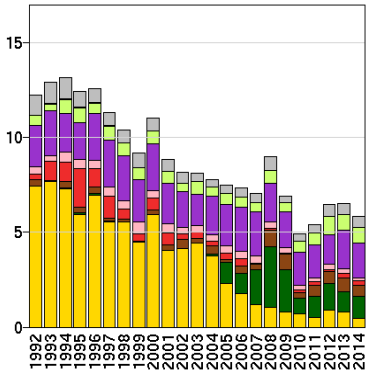
Acetochlor



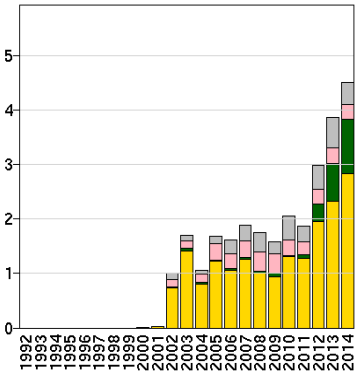
S-Metolachlor



Dicamba



Chlorpyrifos



Dimethenamid-P

"Estimated Annual Agricultural Pesticide Use." U.S. Geological Survey. Page Last Modified February 01 2017. Accessed 20 June 2017

Proliferating Problems with Pesticide Dependency

Human Health Impacts

From the beginning, synthetic pesticides have prompted human health concerns because of their principal design as diluted biological poisons intended to harm targeted living organisms. In fact, German and British scientists used early organophosphate insecticides to develop chemical weapons for World War II.[xiv] While scientists have known for years that pesticides can cause health problems, the medical understanding of how and to what extent pesticides can cause bodily harm has continually progressed over time. Today, scientists still have unanswered questions, but overall, the medical community agrees that many pesticides can lead to significant health problems for people.

[xv] *(Infographic: PAN International, 2016)*

In 2015, the American Association of Poison Control Centers reported that of the 2.2 million poison exposure cases, 72,600 cases (3.3%) were from pesticides, ranking pesticides in the top ten causes of acute poisoning.[xvi] Epidemiological studies worldwide have linked cancer, neurodegenerative diseases (such as Parkinson's disease and Lou Gehrig's disease), neurological problems, reproductive harm, birth defects, endocrine disruption, organ damage, and other illnesses from pesticide exposure.[xvii] For example, Glyphosate, the world's most-popular herbicide was declared by the World Health Organization in 2015 to be a probable carcinogen. Other studies have linked Glyphosate to reproductive effects and endocrine disruption.[xviii] 2,4-D also is an endocrine disruptor and likely carcinogenic.[xix] Chlorpyrifos has been shown to cause hormonal and reproductive harm as well as damage to neurological development, especially in society's most vulnerable population: children.[xx] New research is analyzing the threat of neonicotinoids on the nervous system. The list goes on. In sum, pesticides must continue to be regarded as dangerous or at least, very risky for public health long-term.

Ecological Damage

As previously mentioned, pesticides can benefit the environment to a degree by helping control invasive or nuisance flora and fauna. However, there is agreement among scientists that pesticides disrupt healthy ecosystems. Pesticides can poison the entire food chain. Underground microbial bacterial and microorganisms, beneficial plants, flying pollinators (insects, birds, and bats), aquatic life (fish, amphibians, and aquatic invertebrates), terrestrial vertebrates, and small mammals can all experience collateral damage via air and water contamination from pesticides.[xxi] Pest predators that naturally aid pest problems (beneficial insects) are also killed by pesticides, eliminating a

source of natural pest protection. Thus, pesticide use can compromise key ecological functions, worsening the biological economy for all.

Pollinator population declines perhaps best illustrate the ecological risk. Biologists associate recent dramatic population declines in butterfly and bee populations to the dramatic rise in use of neonicotinoid insecticides and ongoing losses in plant habitat. **The Eastern Monarch butterfly has declined more than 80% since the mid-nineties.**[xxii] Today, at least half of the native bee populations in North America are declining, and one in four native bee species faces extinction.[xxiii] **Honey bee colonies have been declining at rates of 35-44% each year, in recent years –** again, all corresponding to increased pesticide use, although many sources cite a combination of factors.[xxiv] Plants, both for habitat and food, are dependent on these pollinators for survival. About 35% of agricultural crops require pollinators' services along with approximately 85% of all wildflowers.[xxv] Pollinators are responsible for $18 to $27 billion in crop production values annually in the United States with native pollinators contributing an estimated $3 to $4 million in pollinator services.[xxvi]

Pesticide Resistance

The most ironic problem with pesticide dependency is that continued use is making weeds and pests stronger, thus making the pesticide less effective. Pesticide resistance occurs when an organism adapts to survive the normal killing power of a pesticide. Resistance happens as organisms follow the genetic-evolutionary process, where the best-adapted biotypes survive and pass chemical-resistant traits to the next generation. The effect of pesticide resistance, due to overuse of pesticides, is rendering common chemical control methods less effective, thus increasing the costs for farmers and land managers by requiring greater quantities of chemicals or specialized chemicals to be used for recourse.[xxvii]

In Kansas, herbicide resistance is a major issue as scientists have documented resistance in at least 13 different plant species to five different herbicide treatments. Herbicide-resistant plants in Kansas include Palmer amaranth, Tall water hemp, Kochia, Horseweed, and Common Ragweed. The herbicides that plants are becoming resistant to include: Glyphosate, Atrazine, Dicamba, Chlorsulfuron, and more.[xxviii]

Nationally, about 160 herbicide-resistant weeds have evolved, mostly in the last two decades. The same trend holds true for weeds worldwide, whereas 250 weeds in total have developed a combined resistance to 23 of 26 known herbicide sites of actions (biological schemes) and 163 different weed species.[xxix]

Insects are becoming more resistant, too. Examples are the Corn Earworm, the Corn Root Worm, and the Fall Armyworm species, which have all developed some level of resistance to pyrethroid and Bacillus Thuringiensis insecticides in recent years. Genetically engineered seed treatments were aimed to help farmers combat these pests, but some of these pests evolved resistance traits as fast as three to five years after their introduction.[xxx]

Climate-change is further worsening pest management efforts with pests surviving warmer winters and migrating to new habitats.

Drift

Pesticide drift is another problem that is 'blowing up' for farmers, land managers, and their neighbors, resulting from on-going and increased pesticide use. Though spray drift has long been a negative threat of pesticides, the factors of a more crowded populace, a heightened awareness and public sensitivity to pesticides, increased organic farming, obliterated pollinator numbers, and popularized herbicide-tolerant crops have all boosted drift concerns across the country.

When a pesticide travels beyond its intended target, it may imperil the safety and health of people, harm plants and animals, and affect ecosystems. Certainly, not all drift is harmful or illegal. To the extent that a pesticide will drift, its potential impacts depend on such factors as the pesticide's formulation, the amount used, the application method, the weather, and – most critically – decisions by the applicator. It is important to note that not all drift occurs as a result of an improper application, but weather changes and a pesticide's volatility can cause a pesticide to travel elsewhere unexpectedly. That said, others argue that any drift affecting non-target areas, especially when exposure to people and sensitive crops and ecosystems occurs, constitutes a wrongful application according to label requirements.

Currently, drift of the pesticide Dicamba and its impact on soybean and cotton fields across millions of acres in Midwestern and Southern states is making major news headlines and even prompting state government action. Kansas is no exception. Here is a July 12th, 2017, news release from the Kansas Department of Agriculture:

Kansas Department of Agriculture Responds to Herbicide Use Complaints

The Kansas Department of Agriculture has experienced an increase in herbicide misuse complaints alleging crop damage due to herbicide products containing dicamba. KDA's pesticide and fertilizer program staff are actively investigating these complaints for noncompliance with state and federal laws…

KDA strongly encourages all users of herbicides, including products containing dicamba, to be attentive to label requirements when selecting and applying products (not all dicamba products are labeled for soybean application), to be aware of vegetation on surrounding properties, and to be vigilant of weather conditions. Meticulous cleaning of tanks, hoses and nozzles used for herbicide applications is necessary to prevent chemical carryover to the next application. Caution is especially important if you have crops in different growth stages, e.g. double cropping soybeans after wheat.

In the fall of 2017, EPA released new label restrictions for Dicamba in 2018, including reclassification as a restricted use pesticide and other stricter label requirements. The Kansas Department of Agriculture has has established a schedule for training on the new label and proper usage.[xxxi]

The U.S. Environmental Protection Agency (EPA) regulates pesticides, and therefore pesticide drift, under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Just five years ago, the EPA responded to the mounting threat of drift and ordered that all spray pesticides manufactured or labeled for sale in the U.S. must display the warning on its label: *"Do not apply this product in a manner that results in spray (or dust) drift that harms people or any other non-target organisms or sites."* The agency has also created the Drift Reduction Technology Program "to encourage the manufacture, marketing, and use of spray technologies scientifically verified to significantly reduce pesticide drift." Currently, the program uses a rating system for spray technology ground or aerial application equipment upon field crops and encourages companies to promote their ratings on their products. Eventually, the program hopes to incorporate the rating system for orchards and vineyards as well.

History and Legal Background

Historical Perspective

For as long as Kansas farmers have concentrated on growing specific crops, they have had to outperform competition from other flora and fauna in order to be successful. Weeds (unwanted plants), fungi, insects, birds, and mammals have all become adversaries of farmers' prized plants over the years. By the turn of the 20th century, Kansas, and rest of the United States, developed ways to prevent these 'pests' from inhibiting crop production, leading to pest control strategies, which by the Second World War, included employing chemical pesticides. The 1940s and 1950s brought forth the first pesticide regulations in America, which governed the sale, authenticity, and efficacy of pesticides. Rachel Carson's breakthrough non-fiction book, *Silent Spring*, put concepts of bioaccumulation of pesticides and their associated health risks to humans and wildlife into public awareness in 1962. Government leaders soon upgraded pesticide law with new consumer protections and the creation of the Environmental Protection Agency (EPA) to oversee the laws. Today, both the EPA and the landmark safeguards of the 1970s represent the chief authority for pesticide law today. The pesticide market boomed in the 1980s and 1990s as farmers favored pesticide-agriculture's laborsaving and user-friendly qualities.

Background on Kansas Pesticide Law

Kansas developed its original Noxious Weed Law in 1937, and began regulating the authenticity of pesticides under the "Kansas Agricultural Chemical Act of 1947" and the licensing of pesticides under the "Termite and Pest Control Act" in 1953. In 1970, the 'Pest Control Act' would be revamped into the "Pesticide Use Law" to allow for criminal damages to be charged for pesticide misuse. Soon after, the Act developed into the "Kansas Pesticide Law" in 1976 to conform to federal regulatory standards and allow for increased state oversight of private pesticide applicators. While the original laws have been revisited and modified over the years (including an added section on Chemigation Safety which is important in protecting groundwater from fertilizer and pesticide contamination in irrigation systems), the Kansas Pesticide Law and Kansas Noxious Weed Laws represent the chief sections of governance regarding pesticide use and controlling weeds.

- "Kansas Pesticide Law" is housed in Kansas Statutes: Chapter 2 Agriculture, Article 24. It contains details on pesticide terms, types of pesticide licenses, licensing requirements, recordkeeping, unlawful acts, penalties and fines, training and supervision of pesticide applicators, authorized executive powers, handling of drift complaints, and much more. Article 24 follows closely-related articles 21 through 23 on Plant Pests, Agricultural Chemicals, and Labeling of Agricultural Products, respectively.

- "Kansas Noxious Weed Law" is in Article 13 of Chapter 2. Kansas has listed 12 statewide noxious weeds (Kudzu, Field Bindweed, Russian Knapweed, Hoary Cress, Canada Thistle, Musk Thistle, Johnsongrass, Leafy Spurge, Bur Ragweed (or Bursage), Pignut, Quackgrass, and Sericea Lespedeza) and two optional extras (Bull Thistle and Multiflora Rose) for counties to control and eradicate. The law empowers the state Secretary of Agriculture to administer the law, while the Legislature controls the addition and subtraction of the listed weeds. This section of law also spells out the cost-sharing abilities for citizen use, county tax powers, notification requirements, and the authority to prescribe control methods for each noxious weed through rules and regulations.

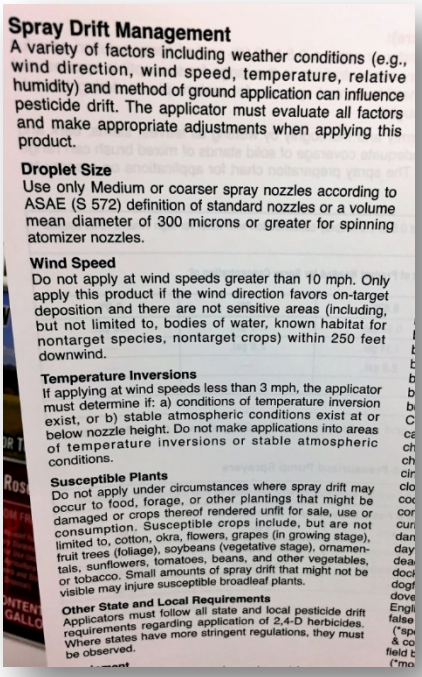
Kansas Pesticide Law

Kansas abides by U.S. EPA standards for complying with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and federal rule that declares **"The Label is the Law"**: This tenet, found in Kansas Statutes 2-2453, reads: "*It shall be unlawful for any person to (a)… use pesticides in a manner which is inconsistent with such pesticide's label or labeling*." Subsection (b) in the law acknowledges the risk of pesticides – via its handling – to the people and the environment by specifying the unlawfulness to "*discard or store any pesticide or pesticide container in such a manner as to cause injury to humans, vegetation, crops, livestock, wildlife, pollinating insects or waterways and wildlife therein…*"

Upon breaking the label law, Kansas law enforcement can charge violators with a Class A misdemeanor, except certified private applicators who can be additionally charged a fine between $100 and $500 per day (K.S.A. 2-2461).

Drift protection is inherently built into the "label-is-the-law" proviso as most pesticide labels dictate something like the following "***application only if the wind direction favors on-target deposition and there are not sensitive areas (including but not limited to, residential areas, bodies of water, known habitat for nontarget species, nontarget crops) within 250 feet downwind."*** Wind speed requirements are also detailed. Finally, many labels specify ***"do not apply under circumstances where spray drift may occur*** *to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use, or consumption."*

However, while the-label-is-the-law proviso may legally provide victims of pesticide drift some protection, proving technical data of wind speeds and specific pesticide-caused drift damage from a certain neighbor can be socially and legally difficult, time-consuming, and burdensome, deterring many noncommercial growers from seeking reconciliation.



Spray Drift Management

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of ground application can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

Droplet Size

Use only Medium or coarser spray nozzles according to ASAE (S 572) definition of standard nozzles or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

Wind Speed

Do not apply at wind speeds greater than 10 mph. Only apply this product if the wind direction favors on-target deposition and there are not sensitive areas (including, but not limited to, bodies of water, known habitat for nontarget species, nontarget crops) within 250 feet downwind.

Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

Susceptible Plants

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Susceptible crops include, but are not limited to, cotton, okra, flowers, grapes (in growing stage), fruit trees (foliage), soybeans (vegetative stage), ornamentals, sunflowers, tomatoes, beans, and other vegetables, or tobacco. Small amounts of spray drift that might not be visible may injure susceptible broadleaf plants.

Other State and Local Requirements

Applicators must follow all state and local pesticide drift requirements regarding application of 2,4-D herbicides. Where states have more stringent regulations, they must be observed.

Example of a general use pesticide label

Kansas law does not clearly identify a definition of chemical drift, nor list any punishments or consumer protections against drift, as some states do. In Minnesota, state law says, "A person may not direct a pesticide onto property beyond the boundaries of the target site. A person may not apply a pesticide resulting in damage to adjacent property." Michigan requires "Pesticides shall be applied in a manner that minimizes the exposure of nontarget humans, livestock, domestic animals, and wildlife to pesticides. Unless permitted by the label, an applicator shall take all reasonable precautions that will prevent a pesticide from being applied if unprotected persons are present within the application site or are present in adjacent areas when off-target drift may occur." In contract, Mississippi defines drift in terms of causing off-site damage: "Drift- shall mean the physical movement through the air at the time of application of a pesticide from the site of application to any nontarget site in sufficient quantities to cause injury to the nontarget site."[xxxii]

That said, in becoming a certified commercial applicator or a certified private applicator, each applicant must pass a core examination that includes knowing: ***the hazards that may be involved in applying pesticides***, including 1) the effect of drift of pesticides *on adjacent and nearby lands and other non-target organisms; 2) the proper meteorological conditions for the application of pesticides and the precautions… 3) the effect of the pesticides on plants or animals in the area, including damage to plants or animals or the possibility of illegal pesticide residues resulting on them; 4) the effect of… pesticides to*

wildlife in the area, including aquatic life… and 6) the likelihood of contamination of water or injury to persons, plants, livestock, pollinating insects, and vegetation (K.S.A. 2-4443b).

Kansas law requires commercial businesses to keep operational records, such "*pest or pests to be controlled, concentration or rate of application, date and location of application, and the wind direction and velocity*" (K.S.A. 2-2455), and recordkeeping for certified private applicators using *restricted use* pesticides. However, **private individuals using *general use* pesticides are not bound by licensing, training, recordkeeping, or liability insurance requirements.** Therefore, basically any individual can legally apply these agro-chemicals without any formal supervision or advanced education aside from what is specified in the label's instruction.

Kansas law does cite examples of unlawful acts only by certified applicators, including the refusal or neglect to keep and maintain records, making false records or reports, using improper methods or materials, "*use any method or material without regard to public health, safety, or welfare*;" and ***"use, store, dispose of any pesticide material… without regard to public health or environmental damage"*** (K.S.A. 2-2454). Again, no stipulation is made upon those uncertified.

In Kansas, *only* commercial pesticide applicators must have liability insurance and credit guarantees for their businesses. The liability coverage must not be less than $25,000 for bodily injury liability and not less than $5,000 for property damage liability. The letter of credit needs to be at least $6000 (K.S.A. 2-2448). Other pesticide applicators assume the personal risk involved and are subject to price of damages as determined by civil or administrative courts or settlement. It is currently questionable whether farmers' common liability insurance will cover pesticide drift, as drift coverage varies by the insurance plan / company.

Kansas' pesticide statutes state the process for which a claim of drift damage shall be processed. Victims must file a report with the Secretary of Agriculture within 60 days after the date the damage was noticed. The complainant can file the complaint online, will be asked for basic landowner information, and then a Department investigator can opt to inspect the site, take photos, take witness and respondent statements, take lab samples, check weather records, and more (K.S.A. 2-2457a).

Kansas law gives the Kansas Department of Agriculture the authority to limit pesticide use and promulgate certain pesticide restrictions "*whenever the secretary deems it necessary to preserve the health, safety, and welfare or the natural resources of the state"* (K.S.A. 2-2471). The KDA secretary can also develop 'pesticide management areas' in consultation with a state technical advisory committee. (None exist today.) Ninety-day temporary areas or permanent areas with prescribed management plans can both be created for certain areas. Any person(s) violating a pesticide management area plan could incur a civil penalty of no less than $100, but no more $5000 upon each violation (K.S.A. 2-2475-78).

In Kansas, the state has exclusive jurisdiction over regulating pesticides, and subdivisions such as **cities or counties cannot enforce any ordinance or rule in conflict or beyond that provided by the Kansas Pesticide Law** without explicit state authorization (K.S.A. 2-2480).

The State of Kansas has enlisted Driftwatch, an online sensitive crop registry, to allow for voluntary communication and mapping for producers and pesticide applicators to be aware of sensitive or organic sites. Producers must enroll their farms to be on the list. It is unclear whether the Kansas Department of Agriculture continues to update data in Driftwatch to accurately reflect newer sensitive crop areas.

Kansas Administrative Rules and Regulations

Article 13 of Kansas Administrative Regulations provides detailed governance of pesticides in Kansas. These regulations specify the licensing and examination requirements of commercial applicators, private applicators, and pesticide dealers, as well as registration fees, chemical storage requirements, penalties, types of hearings, and more.

Both commercial and private applicators are to be tested for understanding of a pesticide label, proper pesticide application, and prevention of environmental harm.

For commercial applicators, K.A.R. 4-13-13 requires knowledge on:
(1) "*using each pesticide in a manner that is consistent with the information and instructions on its labe*l"
(3) *"the potential damage to the environment from use and misuse of pesticides…"*
(7) "*unnecessary pesticide use and pesticide misuse, and prevention of pesticide loss into the environment through* ***drift*** *and other means."*
Agricultural pest controllers must realize "*practical knowledge of the crops grown in Kansas and the specific pests commonly associated with these crops, potential soil and water damage, preharvest intervals, reentry intervals, phytotoxicity, environmental contamination, nontarget injury, and potential adverse effects on the community that are related to the use of restricted pesticides in agricultural areas."*

Similarly, in K.A.R. 4-13-14, private applicators are required to understand:
(b) *"read and understand the label… including the common name of the pesticide applied, pest or pests to be controlled, timing and method of application…"*
(c) "*apply pesticides in accordance with label instructions and warnings"*
(d) "*recognize local environmental situations that must be considered during application to avoid contamination"*

Another important detail of the rules and regulations section is listed in K.A.R. 4-13-40, where an adjudicative hearing may be used for processing violators of the Kansas pesticide law. Notably this type of hearing is allowed for the following types of actions:
(1) "*A reprimand, warning, or disciplinary report pertaining to a violation of the Kansas pesticide law or any implementing regulation"*
(3) "*assessment of civil penalties pertaining to a violation of the Kansas pesticide law or any implementing regulation"*

Kansas Case Law

Judicial precedent in Kansas may be beneficial to drift victims, where statute may not. In Binder v. Perkins in 1973, a case in which 2,4-D damaged an alfalfa crop, the Kansas Supreme Court held that "*the duty of care imposed upon the crop sprayer… is a matter for the courts, and the trial court in this case has characterized 2,4-D as a dangerous instrumentality handling of it a hazardous activity, and has imposed upon the one handling it a duty to prevent its escape.*" The Supreme Court echoed the lower court's quote: "*The evidence shows that here there was a high concentration of 2,4-D and in a preparation resulting in a high degree of volatility to be applied to weeds of large and advanced growth and on a field of wheat headed out and within about a week of the time of harvest, all conditions which would further tend to prolong the evaporation period. The defendant knew the position of the plaintiff's alfalfa field. The evidence showed the wind changed… the court finds from a preponderance of evidence the defendant negligently permitted the 2,4-D to escape from the land where applied by defendant into contact with the plaintiff's growing alfalfa, and this was the proximate cause of destroying the plaintiff's alfalfa field."*[xxxiii]

Other State Rulings and Statutes on Drift Damages

Some state courts, like Oklahoma, Louisiana, and Washington, have ruled in favor of chemical trespass law on a property rights' issue. Other states, such as Texas, Vermont, and Virginia, have increased levels of liability insurance for commercial applicators, assuring some financial responsibility for drift damages. Maine's state court has ruled upon drift safeguards with off-target area chemical residue limits. Louisiana requires physicians to report cases of pesticide injury. Michigan requires any and all drift damage to be reported by anyone, not just the claimant. Alaska, Alabama, and Florida have specified wind speed requirements in law. Maine requires adjacent applicators to notify nearby landowners of pesticide spraying in advance.[xxxiv]

Kansas Noxious Weed Law

Kansas' noxious weed law commands each county to appoint a weed director and levy taxes for a county weed eradication fund. While each county weed director acts as the chief local legal enforcement, Kansas law dictates that all residents share the duty *"to control the spread of and to eradicate all weeds declared by legislative action to be noxious…"* (K.S.A. 2-1314). The law instructs county weed departments to utilize state-prescribed control methods for each noxious weed, and to compel through fine, penalty, and authorization to enter premises and take action, to rid their jurisdiction of noxious weeds. The state backs a variety of weed and pest control methods, including cultural practices like mowing, tilling, burning, and dig-removal, pre-approved biological control methods, and chemical control.

Each year, county weed departments survey district lands for noxious weed infestation and submit annual reports to the Secretary of Agriculture describing the extent of the weed problem, the management strategy, and end-of-year results.

Regarding penalty, any person(s) *or government official* charged and found guilty of noncompliance of the Noxious Weed Law will get a misdemeanor and fine of $100 per day up to a maximum fine of $1500. Practically, counties rarely prosecute violators, choosing instead to enforce Noxious Weed law by allowing the county's weed department to enter a property to service the weed after several notices, then sending an amount owed afterward or holding the expense against the landowner's county tax roll. As previously mentioned, Kansas Noxious Weed Law does give financial capabilities to counties to levy taxes to recover their costs as well as issue cost-sharing for the county's noxious weed control.

Depending on the tax levy amount, counties can incentivize in-district landowners to use chemical controls by providing cost-savings of a quarter to half on the price of county-provided pesticides. Counties are required to keep detailed records and receipts of use and sales of any equipment or chemicals. No incentives exist to encourage cultural or biological controls.

Recent Attempts to Reform Kansas' Noxious Weed Law

Since 2015, efforts to reform Noxious Weed Law in Kansas have been made by legislators and lobbying interests. Essentially, these attempts came down to transferring the designating power of the state's noxious weeds from the Legislature to the Executive branch, i.e. the Kansas Department of Agriculture (KDA), to improve proficiency and timeliness in weed control. The reform calls for an appointed advisory committee to assist KDA in considering the weed-listing, plus provides more flexibility and discretion to KDA in reporting and funding elements.

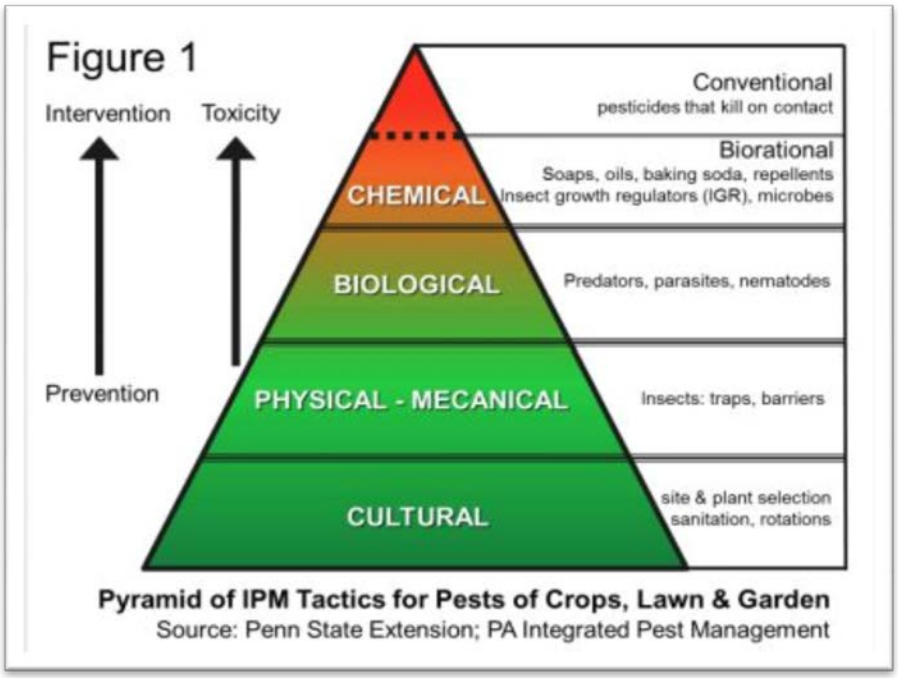
Legislation proposed: SB 134 (2015), HB 2479 (2016), HB 2246 (2017)

Supporters of the legislation reasoned that the KDA could capitalize on its ongoing attention and insight into the noxious weed problem and provide a quicker turn-around time in making decisions compared to lawmakers. They also endorsed a greater cost-recovery for county services and an increased penalty of $200 per day as increased enforcement measure to solicit greater participation in control measures. Opponents warned that the legislation placed a greater burden on private property owners and expands governmental interference in private property. Allowing county weed personnel greater access to private property and eventually the authority to apply toxic chemicals feels like government overreach to some opponents. The change, which included greater cost-sharing for chemicals, also would encourage greater use of chemical controls with no consideration for alternatives and no practical or useful recourse for drift protection. This would impact the emerging specialty crop industry, the expanding grape and wine industry, certified organic production, and increase public health risks and ecosystem health. Opponents also expressed concern over the make-up of the advisory committee (which in early legislation appeared industry heavy and lacking ecological interests or expertise) and argued that we need a definition of drift in Kansas law in general and better safeguards for neighbors, non target sites, etc.

Another Option

Agro-Ecological Farming Systems and Integrated Pest Management

One alternative or solution to curbing noxious weeds and relinquishing continued dependence upon toxic chemical pesticides is the transition to 'agroecology' farming and land management system, and incorporating Integrated Pest Management practices. An agroecological farming system relies on biology and diversification and building soil health. The diversification (i.e. complex crop rotations as opposed to mono-cultured cropping systems, and multi-species grazing systems or pastures) required to build soil health also creates environments less hospitable to pests (weed and insect).



Integrated Pest Management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pest control choices are selected and applied in ways that minimize risks to human health, beneficial and non-target organisms, and the environment. In an IPM approach, pesticides are used in limited amounts, only after monitoring indicates they are needed and with the goal of removing only the target organism.

The key takeaway of IPM is that the most effective, long-term way to manage pests is by using a combination of methods that work better together than separately. Biological controls utilize *natural enemies*—predators, parasites, pathogens, and competitors—to control pests and their damage. Cultural controls are practices that reduce pest establishment, reproduction, dispersal, and survival. Strategic plant and site selection, crop rotation, and growing techniques are all examples of cultural controls. Mechanical and physical controls such as tilling, mulching, intercropping, using cover crops, burning, and more, all help kill a pest directly, block pests out, or make the environment unsuitable for pests without using long-lasting toxic chemicals.

Public outreach and education by state and county governments, universities, and nonprofits can help landowners understand how to employ a balanced agroecological farming system and IPM pest defense, including smarter pesticide application, ways to combat noxious weeds without chemicals, and even protect one's property from drift damage. These efforts range from improved extension services, informational handouts at farm shows, to community events featuring farm equipment cleaning and sprayer equipment calibration.

Kansas State University has an Integrated Pest Management Program that offers Pesticide Safety Education and Integrated Pest Management education and outreach through Extension. The Pesticide Safety Education Program focuses on the training and certification of commercial and private applicators, as well as provides general education for homeowners and Master Gardeners, and Ag Safety programs for children. There is no single Integrated Pesticide Management course or bundle of courses at KSU, but IPM is part of many different disciplines so is touched on across multiple disciplines and departments at KSU, including agronomy, plant pathology, horticulture, entomology, and animal science. While this is valuable education and a critical service, the question is whether more emphasis is needed on agro-ecological farming practices and approaches, or a combination of chemical, cultural and biological practices in addition to chemical pesticide information?

Private crop consultant companies also provide education and scouting, but appear to often focus on chemical solutions. A few companies are responding to market demands for pesticide-free products, fueled by consumer concerns, and by weed resistance and loss of efficacy of some products, as well as the high costs of chemicals. These companies are offering Integrated Pest Management analysis and strategies that do not necessarily call for chemical solutions, or offer more strategic use of those chemicals.

Recommendations

Recent legislation has focused on questions surrounding a change in authority of the state's noxious weed law or on adding additional weeds to the state list or county special list. However, as we stated at the beginning of this overview, focusing solely on noxious weeds begs the broader question of pesticide use in general, and ignores the problems or issues plaguing current use, and ignores potential issues with expanded use of chemical controls. Adopting an approach that encourages or incentivizes non-chemical or cultural, biological controls would lessen the danger or threats from those who do opt to use chemical controls, and could actually help maintain the efficacy of chemical controls. Such an approach that meshes the needs to build soil health, protect water quality, and limit human exposure to pesticides provides the most workable, practical approach for a long term sustainable future.

Recognizing that the Kansas State Legislature is likely to address noxious weed law regardless of the other pressing issues surrounding pesticide use, we offer recommendations below to address improving the state's noxious weed management program separate from comments on developing an overall pest management approach that would lessen dependency on chemical pesticides for agriculture as a whole.

Noxious Weed Law

1. Develop or improve the existing education and outreach on controlling noxious weeds to landowners, farmers, and ranchers to encourage greater management efforts.
2. Encourage non-chemical approaches the same way we encourage or incentivize chemical controls. It will take an integrated approach to address serious infestations.
3. Create a State Pesticide Management Advisory Council to address both noxious weeds and pesticide drift with well-balanced expertise including agro-ecology representatives, and certified organic or specialty crop representatives. Task the Council with developing a risk assessment process for identifying transformative invasive weeds and prioritizing needed research into topics and issues that will expand Integrated Pest Management solutions.
4. Protect private property rights of landowners and farmers and ranchers by leaving the ultimate authority of declaring noxious weeds in the hands of the State Legislature with the input and advice of a State Pesticide Management Advisory Council.

Pesticide Law and Chemical Drift Protection

1. Develop or improve education, funding, research, and outreach on Integrated Pest Management practices for Kansas agriculture.
2. Define pesticide drift and develop protections for those impacted by it.
3. Create an additional authority in the administrative adjudication process (K.A.R. 4-13-40) for parties to voluntarily opt for resolving pesticide drift damages and compensation via "consent to mediation" instead of having to go to court.
4. Explore opportunities to expand insurance options for the pesticide applicator and/or specialty crop grower to enhance protections in chemical drift circumstances.
5. Create a recordkeeping or permit obligation, such as a logbook or county call-in, that requires private applicators to record details of their pesticide application: such as the area, location, method, time, and date of their application, type and amount of pesticide(s) used, wind direction and velocity, and whether notification to adjacent property owners was given.
6. Implement a mandatory sign up with the Driftwatch program by landowners, farmers, and ranchers to submit sensitive crop location information so that those applying pesticides can quickly and easily identify areas needing greater protection.
7. Review and monitor controversial pesticides (such as Dicamba and Chlorpyrifos) to consider designation as a restricted use pesticide (under Kansas law) to protect the Kansas agriculture economy, private property rights, public health and environmental damage, and right-to-farm fairness between farmers. Prepare a state plan to address potential conflicts.

Conclusion

As agriculture continues to evolve and consumer awareness of public health and environmental damage continues to grow, the discussion of pesticide use, weed control, and drift protection will expand. The conversation will enter even more into statehouses and courtrooms, as well as talks between neighbors. The best outcome can be gained through a proactive, cooperative approach in which all parties involved agree to listen, be forward-thinking, and to practice better responsibility and stewardship in all their capacity.

Advances in technology, farming and land management systems, and government policies can all aid the necessary agricultural transition from a pesticide-based agricultural model to that of agroecology and the common acceptance of sustainable farming and integrated pest management. With heightened accountability, creative thinking, and open-mindedness at the individual, societal, and ecological levels, Kansans and the rest of the global community can work to solve the challenges of noxious weeds and pesticide dependence successfully together.



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